

Influence of Foliar Application of Water-Soluble Boron on Sunflower Productivity

Oleksandr Dobrenkyi*

National Academy of Agrarian Sciences of Ukraine

***Corresponding Author**

OLEKSANDR DOBRENKYI, National Academy of Agrarian Sciences of Ukraine.

Submitted: 2025, June 20; Accepted: 2025, July 21; Published: 2025, July 28

Citation: DOBRENKYI, O. (2025). Influence of Foliar Application of Water-Soluble Boron on Sunflower Productivity. *J Water Res*, 3(3), 01-04.

Abstract

Study evaluates the effect of foliar application of water-soluble boron on the productivity of sunflower hybrids *Biloba CLP* and *Suvex* in the Kharkiv region during 2022–2024. Experiment was carried out in the Eastern Ukraine region to determine the effectiveness of boron fertilization in different phases of vegetation (V8–V10, R1–R2, and combined application). The effect of boron on the yield, depending on the application rate (1.5 l/ha and 3.0 l/ha), was analyzed. The results obtained indicate that boron fertilizing did not provide an increase in yield, and in some cases led to its decrease. The smallest decrease was observed when boron was applied in the R1-R2 phase at a rate of 1.5 l/ha, where the yield remained almost at the Check level.

Keywords: Sunflower, Boron, Yield, Climatic Conditions, Crop Quality

1. Introduction

Boron plays a key role in the production of oilseeds. Sunflower is one of the most sensitive crops to the deficiency of this nutrient [1]. One of the main reasons for the low productivity of sunflowers is poor seed production and a high percentage of husks. It is known that trace elements play an important role in increasing the percentage of seeds in sunflower inflorescences and affect the growth and formation of crop yields. Consequently, the yield of seeds can be increased due to the use of trace elements, among which boron plays a particularly important role. Boron can affect photosynthesis and respiration and activate several enzymatic systems for the metabolism of protein and nucleic acids in plants [2].

Boron is called an unconstitutional element because it does not form components/compounds in the plant system but acts as a plant nutrient with a vital role in metabolism, including protein synthesis, maintaining the water balance of plants [3]. In addition to its main role in metabolic processes and grain formation, boron improves the quality of agricultural products, increases resistance

to pests and diseases and tolerance to low temperatures [4]. Boron deficiency reduces yield and oil content and negatively affects the unsaturated/saturated fatty acid ratio [5]. Thus, the use of boron plays an important role in increasing production [6,7].

Our work was aimed at studying the effectiveness of foliar application of water-soluble boron on the productivity of sunflower hybrids.

2. Materials and Methods

The experiment was conducted in the Kharkiv region, Lozova district, Nova Ivanivka village, Lozova APTS LLC, during 2022–2024. The study was carried out to assess the effect of water-soluble boron applied in different phases of vegetation on the productivity of sunflower hybrids *Biloba CLP* and *Suvex*. The analysis was carried out according to three-year data (2022–2024), comparing the yield of the Check variant (without boron application) and variants with boron application (Spectrum Boron 150) in phases V8–V10, R1–R2, and combined application (V8–V10 + R1). Two boron rates were applied – 1.5 l/ha and 3.0 l/ha (Table 1)

Application rate, l/ha	Growing Stage	Hybrid
Check	–	Biloba CLP
		Suvex
1,5	V8-V10	Biloba CLP
		Suvex
	R1-R2	Biloba CLP
		Suvex
	V8-V10 (0.5 l/ha) + R1-R2 (1.0 l/ha)	Biloba CLP
		Suvex
3,0	V8-V10	Biloba CLP
		Suvex
	R1-R2	Biloba CLP
		Suvex
	V8-V10 (1.25 l/ha) + R1-R2 (1.75 l/ha)	Biloba CLP
		Suvex

Table 1: Scheme of the Experiment. The Effectiveness of Foliar Application of Water-Soluble Boron on Plant Productivity.

Soil analysis was carried out before sowing each, according to which in 2022 the soil contained 1.83 kg/ha of boron, in 2023 – 2.19 kg/ha and in 2024 – 0.81 kg/ha, respectively. Soil analysis data indicated a sufficient amount of boron available to obtain the planned yield without additional fertilization.

The experimental period (2022–2024) was characterized by significant variability of climatic conditions, in particular the amount and monthly distribution of precipitation, which directly affected the growth and yield of sunflower (Table 2). In 2022, the total amount of precipitation during the growing season (April–September) was 179 mm, which is significantly lower than the long-term average (by 54 mm). The main rainfall deficit was observed in May (11 mm) and June (10 mm), which caused water

stress at critical stages of growth and development, such as early vegetative growth, flowering, and seed filling. Such conditions led to a decrease in yield and oil content.

In 2023, rainfall for the same period was 249 mm, which exceeded the long-term average by 16 mm. Precipitation in April (105 mm) significantly exceeded the average annual by 60 mm, which provided sufficient moisture for the initial development of plants. However, there was a significant moisture deficit in May and June. Precipitation in July (42 mm) partially compensated for the lack of water, but at the same time caused lodging of plants in some areas, which negatively affected the yield. In 2022 and 2023 (1559 and 1651°C/days), the sum of active temperatures was sufficient for mid-early hybrids (1700–2100°C/day).

Year	Moon						Difference with the average weight.
	April	May	June	July	August	heather	
Average daily temperature(°C)							Sum of active temperatures (°C/days)
2022	11,8	16,4	21,6	24,3	23,8	17,2	+71 (1559)
2023	12,0	17,2	22,0	25,0	24,5	18,0	+163 (1651)
2024	15,5	16,4	23,2	26,6	24,6	21,0	+610 (2098)
3-year average	12,1	16,7	22,3	24,5	23,8	17,4	+281 (1769)
Average perennial	11,8	16,4	20,2	22,4	21,6	16,2	0 (1488)
Amount of precipitation (mm)							The amount of precipitation for the average annual (mm)
Year	April	May	June	July	August	heather	
2022	44	11,0	10,0	31,0	45,0	34,0	-54
2023	105,0	29,0	29,0	42,0	30,0	14,0	+16
2024	14,0	12,0	29,0	44,0	1,6	11,0	-121,4
3-year average	53,8	20,0	29,0	40,3	39,2	29,7	-21
Annual Average	45	29	34	42	45	38	0

Table 2: Average Daily Temperature (°C) and Precipitation (mm) for the Research Period.

In 2024, the amount of precipitation during the growing season was 111.6 mm, which is significantly lower than the long-term average by 121.4 mm. Moisture deficiency was particularly pronounced in May (12.0 mm) and August (1.6 mm), which are critical phases for vegetative growth and seed filling. The sum of active temperatures reached a level optimal for mid-season hybrids (2100–2300°C/day), which indicates unfavorable temperature conditions for mid-early hybrids used in the experiment. Also, the lack of precipitation significantly affected the development of sunflowers, which led to a decrease in yield and a deterioration in the quality of oil.

3. Results and Discussion

The main purpose of the research was to determine the effectiveness of boron application in different phases of sunflower vegetation and its effect on the yield of Biloba CLP and Suvex hybrids in comparison with the Check variant, where boron was not used. The analysis of the data obtained showed that among all the options for applying water-soluble boron, none provided a positive increase in yield compared to the Check.

The smallest yield losses were observed when boron was used in the R1-R2 phase at a rate of 1.5 l/ha, where the average yield for both hybrids was 4.16 t/ha, which is only 0.14 t/ha or 3% less than in the Check (Table 3).

Separately, for the Biloba CLP hybrid, the yield in this variant was at the level of 4.34 t/ha, which is only 0.03 t/ha or 1% below the Check value, while for the Suvex hybrid the decrease was more significant – 3.98 t/ha, which was minus 0.24 t/ha or 6% relative to the Check.

The use of boron in the V8-V10 phase with the same rate of 1.5 l/ha had slightly worse results. The average yield was 4.08 t/ha, which is 0.22 t/ha or 5% below the benchmark. For the Biloba CLP hybrid, the decrease was 0.36 t/ha or 8%, and for Suvex it was only 0.08 t/ha or 2%, indicating a slightly better adaptability of this hybrid to the use of boron in the early phases of development.

The largest yield losses were recorded with combined boron application in the phases V8-V10 (1.25 l/ha) + R1-R2 (1.75 l/ha), where the average yield decrease was 0.71 t/ha or 17%. For the Biloba CLP hybrid, the yield fell to 3.62 t/ha, which is 0.74 t/ha or 17% below the Check level, and for the Suvex hybrid, the yield was 3.54 t/ha, which is 0.68 t/ha or 16% less than in the Check. Similarly, the application of boron at an increased rate of 3 l/ha in the R1-R2 phase also showed a significant decrease in yield, which confirms the negative impact of excessive application of the trace element in the late phases of development (see Table 3).

Application rate, l/ha (A)	Growing stage	Hybrid (C)	Year (D)				Average gain to Check		
			2022	2023	2024	Average	t/ha	%	
Check	–	Biloba CLP	4,70	3,90	4,50	4,37	-	-	
		Suvex	4,10	4,50	4,07	4,22	-	-	
		Average	4,40	4,20	4,29	4,30	-	-	
1,5	V8-V10	Biloba CLP	4,30	3,60	4,13	4,01	-0,36	-8	
		Suvex	4,00	4,50	3,92	4,14	-0,08	-2	
		Average	4,15	4,05	4,03	4,08	-0,22	-5	
	R1-R2	Biloba CLP	4,60	3,90	4,51	4,34	-0,03	-1	
		Suvex	4,00	4,10	3,85	3,98	-0,24	-6	
		Average	4,30	4,00	4,18	4,16	-0,14	-3	
	V8-V10 (0.5 l/ha) + R1-R2 (1.0 l/ha)	Biloba CLP	3,90	3,80	4,07	3,92	-0,44	-10	
		Suvex	4,00	4,10	3,97	4,02	-0,20	-5	
		Average	3,95	3,95	4,02	3,97	-0,32	-7	
3,0	V8-V10	Biloba CLP	3,80	3,70	3,80	3,77	-0,60	-14	
		Suvex	3,90	4,30	3,87	4,02	-0,20	-5	
		Average	3,85	4,00	3,84	3,90	-0,40	-9	
	R1-R2	Biloba CLP	3,80	3,90	3,40	3,70	-0,67	-15	
		Suvex	3,90	4,30	4,02	4,07	-0,15	-4	
		Average	3,85	4,10	3,71	3,89	-0,41	-10	
	V8-V10 (1.25 l/ha) + R1-R2 (1.75 l/ha)	Biloba CLP	3,60	3,90	3,37	3,62	-0,74	-17	
		Suvex	3,30	4,10	3,23	3,54	-0,68	-16	
		Average	3,45	4,00	3,30	3,58	-0,71	-17	
		NIR05	A – 0.15; B – 0.14; C – 0.21; D – 0,30 ; AB – 0.31; AC – 0.37; AD – 0,48; BC – 0,34; BD – 0.44; CD – 0.53; ABCD – 0.71						

Table 3: Yield of Sunflower Biloba CLP and Suvex Depending on the Application of Boron in Different Phases of Vegetation.

4. Conclusions

It was found that the application of boron in the studied schemes did not contribute to an increase in sunflower yield, and in most cases, on the contrary, led to its decrease. The smallest decrease was observed when boron was applied in the R1-R2 phase at a rate of 1.5 l/ha, where the yield remained almost at the Check level, especially for the Biloba CLP hybrid. At the same time, an increase in the application rate or the combined use of boron in two phases of development led to a significant decrease in yield, which indicated a possible stress effect of an excessive amount of this trace element on sunflower plants. This emphasizes the need to optimize boron fertilization schemes, considering the specifics of hybrids and phases of crop development, as well as the content of boron in the soil.

Reference

1. Blamey, F. P. C., Mould, D., & Chapman, J. (1979). Critical Boron Concentrations in Plant Tissues of Two Sunflower Cultivars 1. *Agronomy Journal*, 71(2), 243-247.
2. Čupina T., Sakač Z., 1989: Physiological aspects of sunflower yield formation. Faculty of Agriculture, Institute of Field and Vegetable Crops, 1-224.
3. Dobrenkyi O.A., Avramenko S.V. (2024). The yield of sunflower hybrids depended on plant density in the dry conditions of 2024. International Scientific and Practical Internet Conference «State-of-the-Art Technologies in Plant Production 2024»; pp. 56-59.
4. Hu, J., Seiler, G., & Kole, C. (Eds.). (2010). *Genetics, genomics and breeding of sunflower*. CRC Press.
5. Kyrychenko V. V. Breeding and Seed Production of Sunflower (*Helianthus annuus L.*) / V. V. Kyrychenko. – Kharkiv: Magda LTD, 2005. – 386 p
6. Marschner, H. (2012). Marschner's mineral nutrition of higher plants. Academic press.
7. Kirkby, E. A. (2001). *Principles of plant nutrition* (Vol. 1). springer science & Business Media.

Copyright: ©2025 Oleksandr Dobrenkyi. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.